

## Plenary: The Importance of Experiences in Infancy for Later Learning

Ross Thompson: So, it is my honor to be able to start this institute and to be with you. And I want to thank you for being here. Jen had some very kind things to say about my ability to translate research findings and science into practical applications, and I need to tell you why. And the reason is that ever since I have been starting to develop a scientific career relating to early childhood development, I've been married to a gifted early-childhood educator.

And Janet directs the Center on Child and Family Studies at U.C. Davis, and from the beginning of the time that I was doing research on young children, I would come home at the end of the day and talk to her about the work that I was doing and about the theories that I was developing and about the studies I was reading, and she would listen patiently, as any good partner would.

And then when I was finally done, she would say to me, "Well, that's all very interesting, Ross, but let me tell you what they're really like. And then she'd go on to describe what her day was like. And so from the beginning of both of our careers, we've been working together at sort of this challenge of how do you put together cutting-edge science about what we know about how children are developing with the practical knowledge and wisdom that those on the floor with kids have to be able to bring to their work.

And so it's with the deep appreciation of what she does and what she brings to my work that I want to thank you for the good work that you do. The time and energy that you invest in the development of our very youngest children is often unrecognized, and so I want to be one really of many who deeply appreciate what you do, who thank you for what you do, and who appreciate the investment that you're making in very young children. So thank you.

I want to begin with a story. It's a story that you may have heard. Don't know whether it's true or not, but it's certainly entertaining. And the story is a world-class athlete who was renowned for his physical skills. But he was challenged by a friend of his to follow around a baby -- a 12-month-old baby over the course of a single day. So everything the baby did, the athlete said, "You have to do this, too." And the athlete thought to himself, "Well, what kind of a challenge is this? After all, it's just a baby."

And so he started as soon as the child woke up in the morning, and every time the child jumped, he jumped. And every time the child crawled, he crawled. And every time the child climbed up on something, he climbed up on something. And he was exhausted by the middle of the afternoon. Even with a nap, he couldn't make it to the end of the day. And what's wonderful about this story, of course, is what it says about how beneath the casual playfulness and sort of the everyday behavior of a baby that is often overlooked by the adults who watch them, there's a lot of powerful stuff going on.

So the question I want to ask you is this. Suppose, instead of a world-class athlete, we instead considered a world-class scientist. Let's imagine she's a Nobel Prize winner, and one of her friends challenges her not to follow a baby around over the course of the day, but instead to spend the day thinking like a baby with the same outcome result. Would this scientist -- world-class scientist, Nobel Prize winner -- be exhausted at the end of the day trying to think like a baby?

And I want to argue today that they would be, that babies think differently from how adults do, but there is incredible energy and intensity to how they are thinking that, while they are different from how adults think, is part of what helps to prepare them for the lifelong learning and the achievements that will continue to unfold in the years that follow. And I want to suggest that beneath the baby's apparent casual playfulness and sometimes their disorganization and impulsivity is an incredibly powerful mind at work that when we understand how that baby is thinking, we can begin to understand what are the things that we can do to facilitate that child's learning and development of the early years of life?

Now, one of the reasons that we might come to this conclusion, that even a Nobel Laureate would be exhausted by spending a day trying to think like a baby is, as Jen mentioned, all the work that we now have on early brain development. The brain-development research has absolutely been a game changer for our understanding of the early developing brain as a powerful information-processing organ where, literally, the architecture of the brain that will, for the rest of the child's life, provide the tools for learning and cognitive growth and insight and wisdom and thinking and reasoning are all being set into place literally in the early months and years of life.

We know this from what we understand about how rapidly the brain is organizing itself. And I'll have more to say about that in just a moment. The problem we face, however, is that the work on brain development doesn't always seem to fit together with our everyday experience of the behavior of a baby. Just like the world-class athlete, we can sometimes get fooled by the casual playfulness, the impulsivity, the lack of regulation, sometimes the emotional petulance of a typical baby. Somehow, that baby's behavior disguises all the important work that is going on underneath the scalp and the connections that are going on between neurons and the ways in which the brain is organizing itself.

In some respects, it would be a lot easier for us if, instead of acting like babies, babies, instead, acted like Albert Einstein, like smart, wise thinkers who were constantly coming up with new and insightful comments. Of course, it's worth remembering that Albert Einstein didn't always act like Albert Einstein, that there were times that he was also capable of casual playfulness. But the bottom line, and, really, the central idea that is so important for us to grasp is quite simply that babies do not think like adults, and that what the brain research has the potential of telling us about is not only how powerfully the brain is developing in the early months and years of life, but also how that developing brain causes the child, because of its stage of development, to think differently than an adult does.

And if we can begin to grasp how a baby thinks differently than an adult does, then we can begin to grasp why it is that brain depends so much, so heavily on the nurturant and sensitive care of adults to help that brain unleash its learning potential and be able to discover all the wonderful things there are to learn in the world around you.

So, to give you an outline of where I'd like to take us this morning, I want to spend a few minutes with you talking in a little bit greater depth about the brain development research and think a little bit about what it tells us not just about the brain as an information processor, but about the baby as a thinker. And then we'll turn to think a little bit about what are the applications of this for how we, as adults, can help to work with that brain in helping the child exploit every learning opportunity that exists in the world around them. And then finally, we'll wrap up with some concluding comments.

Now, chances are you've heard a lot about the story of brain development. Chances are some of what I'm going to be telling you is going to be familiar, and that's just as well because we always learn from hearing things that we've heard before. But what you probably have heard, which is true, is that not just from the moment of birth, but beginning prenatally, the brain begins generating neurons that are the basic building blocks of its architecture.

Those neurons are represented here in a slide as these kind of funny-shaped little dots of darkness with, it appears, tails and tentacles going out from all directions. Those are basic neurons, the building blocks of the developing brain. And those neurons are formed at an incredible rate, beginning prenatally, for example, neurons are generated at a rate of about 250,000 a minute. So this is one of the most generative, productive aspects of all of development, beginning prenatally. And as those neurons develop, they begin to gravitate, to move throughout the brain, to reach their destination locations.

And in doing so, they begin forming the basic architecture of the brain. They begin creating the structure of brain systems, and then they also begin interconnecting with each other. And it's those interconnections between neurons that form the communication systems of the brain. And one of the important things about what's happening in the early months and years of life, but also beginning prenatally, is that there is a blooming of these connections.

There are exuberant connections going on between all these different neurons. In fact, there are more connections formed between different neurons in the brain than the brain will ever be able to use. In fact, what researchers have pointed out is that a baby's brain at 12 months of age is a more densely packed organ than it ever will be at any future stage of development, and that is because at 12 months of age, the baby's brain literally has lots and lots and lots of connections, many more than the brain can effectively use.

Now, the question we might ask is, "Why would the brain develop that way? Why would there be this exuberant blooming of connections?" And the answer is actually very profound. And that is that the brain is creating an organ of incredible potential, an organ that can be well adapted to different conditions of life into which the child has been born, or might have been born.

Now, it's great to have a brain that has incredible potential, but the problem is that that brain, that kind of brain, that packed, densely interconnected brain doesn't work very efficiently. And so this is why a second step has to take place, which is the pruning of those connections -- a reduction on the number of connections in the brain based on the use-it-or-lose-it principle by which experience helps to determine which connections are retained. You probably heard about this principle. It's the idea, basically, that when -- when connections in the brain are activated based on the child's experiences, that activation naturally strengthens those connections, and they become consolidated.

Other connections that are rarely or never activated eventually wither away from disuse. And the result is that after this pruning period, which is as important as the blooming period -- after this pruning away of unnecessary connections, the brain is now operating at peak efficiency. It is now capable of functioning as an efficient information processing organ. So the goal of brain development is not making lots of connections. It's making the right connections. That's why the pruning is at least important as the blossoming.

Now, why should experience be so important? Why should the brain develop based not only on this genetic timetable, but also on the basis of use-it-or-lose-it, the role that experience plays? The reason is simply that any baby -- any baby is born into an unknown world, and therefore the reason the brain develops all this potential, all this blooming of connections is that it doesn't know what kind of a world it has to adapt itself to. And that's why the brain, at 12 months, as a densely packed organ, is also a brain of incredible potential.

Let me just use a simple example of how this occurs through the study of language development. One of the unknowns a baby is born into a world not knowing about is what kind of language the child will be learning and how to communicate with people around them. The baby cannot know at the moment of birth whether they have been born into a home in London or Paris, into Kiev or Tokyo, into Seoul, South Korea, or Abu Dhabi. And as a result, the brain has to develop the potential to learn almost any human language because at birth, they can't know what language they're gonna have to learn. And that's why, at 6 months of age, a baby's brain is literally capable of making out the sounds of what researchers believe to be all the world's languages.

A 6-month-old baby is figuratively a citizen of the world in their ability to hear speech sounds that might occur in almost any language that they might have been born into. Of course, at that time, at 6 months, the baby is also beginning to overhear language around them. And not all the world's speech sounds are being overheard. And so beginning at early in the first year and continuing on the first year, babies begin -- or the babies' brains, rather, begin reorganizing themselves in such a way that by 12 months of age, they have lost that universal language ability.

But now the brain has reorganized itself to become optimally efficient at learning the one or more languages that they have been overhearing at home. The result is that the brain has transformed itself from a universal language learner into a very, very efficient learner of one or a couple of languages heard at home. And the reason this is so important is that it sets up now the vocabulary explosion that will take place in the year that follows.

As any parent knows, as you know, I'm sure, the child begins learning new words at an astonishing rate in the second year of life. In this figure, we're plotting the rate of vocabulary development over the course of the baby's early months of life, up to 36 months of age, and we're just looking at cumulative vocabulary development. Of course, there's not a whole lot of vocabulary that develops by about 16 months of age. But following that, the baby's vocabulary shoots up at an astonishing rate.

And that is all because of the way in which the brain has reorganized itself in order to become an efficient learner of English, French, Arabic, Spanish, Korean, Japanese, Russian, or whatever other language or languages the child is hearing at home. Pretty amazing stuff. Equally amazing -- If you don't mind. Equally amazing is the fact that this blooming and pruning process occurs in different timetables for different areas of the brain. So, this proliferation of neuro connections and the pruning away of them doesn't occur in all areas of the brain at the same rate. It occurs in different areas of the brain according to different timetables. Now, watch this.

So again, we're plotting the changes that occur over the course of the early months and years, and later years of life, and we're going to be plotting first the blooming of neuro connections, and following that, the equally importantly pruning of connections for different areas of the brain governing different psychological processes. And as you can see, early on, the blooming and pruning takes place for sensory areas, hearing, seeing, because these are so fundamental to everything else that follows. And then somewhat later, as you saw, language development takes place -- that blooming and pruning process.

Somewhat later, you find in other areas of the brain, governing higher cognitive functions, a much more extended blooming of neuro connections followed by the subsequent pruning that extends into adolescence. And watch this. Remarkably enough, areas of the brain that have to do with self-regulation have a developmental process of blooming and pruning that is far more extended. Begins early -- Begins around 12 months of age, but extends to early adulthood. My two sons are in their early adult years, and I think they're just about through with that process.

Now, notice, then, that if we consider all that's going on in the first two years of life, we see that major elements of brain development have already taken place. They are, in very many respects, almost completed. But there are also other aspects of brain development -- not surprisingly, higher thinking, reasoning, abstract conceptual skills -- that have much more development to occur. And notice with respect to self-regulation, there's still a lot of growth remaining. Babies are still taking their baby steps with respect to self-regulation.

Now, the next speaker's gonna have much more to say about this than I, but I want to emphasize this point -- that self-regulation develops very, very slowly. That literally, young children's brains are not often capable of a great deal of self-control. And this is so important because one of the things that national surveys tell us, including those conducted by Zero to Three, is that parents and others who care for babies and toddlers often overestimate the capacities that young children have to manage their impulses, their emotions, their attention, their thoughts, their behavior.

Oftentimes, parents get frustrated when their child erupts in petulant crying, and they don't stop when the parent says, "Stop crying." Or the child doesn't sit still when the parent says, "You got to sit still here. We're in church." And when that happens, parents sometimes believe that if they think the child is capable of self-control but they aren't doing so, then that must mean the child is being intentionally defiant. And this can get into a lot of problems.

The fact is that much of the time, most of the time, we are expecting more in the self-control for young children than their brains are capable of providing. And this means that one of the secrets for us is figuring out, rather than asking the child to do more than their brain is capable of doing, to instead see if we can provide external support to the child's self-regulation to help that poor dorsolateral prefrontal cortex that you see in the figure here and other brain areas do as good a job as they possibly can do.

This is so important that it leads to the first way in which the thinking of infants is different from the thinking of an adult, and that is that they have limited self-regulation. And this manifests itself in all sorts of ways that can cause us to overlook how much is going on in the child's thinking because it means that with respect to their attention, babies are often kind of distractible, and they're often looking from one thing to the other.

And we'll see another reason why this is so, but limited attentional self-regulation is one reason that occurs. It means that sometimes babies don't focus their thinking very much. They don't persist as they're exploring or discovering something new. And that has to do with self-regulation as it relates to cognitive functioning. We all know how limited babies and toddlers are in emotional self-control, and that's also part of that same long-standing developmental process. And of course, they're also very impulsive and can often be as surprised by their limited behavioral self-control as we are. That's part of that self-regulatory process.

So in thinking and in other ways, one of the differences, of course, between babies and adults is that they have limited self-regulation, and recognizing that helps us to be patient in understanding that they aren't thinking in the same way that adults are. They aren't able to do so, and this is why adults are so important in our ability to provide external support for their limited self-regulation ability.

Now, here's a second reason -- or a second way in which the thinking of babies is different from the thinking of adults. And this has to do with the fact that they get terribly excited by novelty, by things that are new in the world around them. It's not just that they are kind of overjoyed by discovering something new. It's really that their brains are oriented toward what is new, and that's one of the reasons that they are able to learn as quickly from so many different aspects of their experience as they do.

Here's kind of like what it's like to be a baby. Being captivated by novelty as things come into view, as things come into attention, generating the excitement of this being different and new and, "What can I learn from this?" and "Boy, boy, this is wonderful," and you can almost see the palpable excitement when a baby is in a new environment and faced with new things to discover and places to explore and people to find out about.

And it just can, at times, as we shall see, prove to be overwhelming. As I mentioned, being excited by novelty and having a brain that is oriented toward novelty is a real advantage because it means that babies are able to learn a great deal from the world around them. That's one of the reasons why our Nobel Prize winner would be exhausted by a day of thinking like a baby because everything provokes great excitement and enthusiasm.

For adults, of course, we're not only oriented toward novelty. We're also oriented toward familiarity. We like familiarity because it enables us to apply what we know from past experience to the current situation. So we're not quite as captivated by novelty as babies are because we have other depths of experience that is helping us when we face something familiar. But to babies, so much is new that it proves to be terribly exciting and, at times, overwhelming. Indeed, this kind of focus on novelty is also hard work, which is why, in fact, babies and toddlers need nap times in order to consolidate their experiences of the earlier hours, and it's why, also, they can so easily be inclined to be emotionally disrupted, to become distressed, to become easily frustrated when simply the amount of stimulation that their captivation by novelty has provoked simply proves to be too much for them, probably as it would be for any world-class scientist.

This is why, despite their incredibly developing and powerful brains, babies need so much sleep and can become so easily overwhelmed and why they need the assistance of adults to help manage all this excitement and stimulation, help channel it in ways that are within the baby's tolerance for stimulation and ability to benefit from.

Okay, so, limited self-regulation, being excited by novelty are two ways in which the thinking of babies is different from the thinking of adults. Here's a third way in which their thinking is different. And that is that they tend to be captivated by immediate experience. Babies focus intently on the moment, on what is before them. Their thinking is very much like, as Alison Gopnik has put it, a spotlight that shines a bright light on a very limited range and allows the observer to see in great detail what is before them. And in many respects, that's exactly how a baby approaches a new experience -- with the focus and intent concentration on what is going on at the moment.

By contrast, adult thinking is more like a search beam. We cast a wide light over a wide variety of aspects of experience. When faced with something in front of us, we focus on what that thing is, but we also look around and see what else is happening at the moment. We look at the reactions of other people. We think about this event in relation to what happened a moment ago, or we begin to consider what comes next.

In short, we cast a wide conceptual beam, and as a result, we're not nearly as good observers as babies are. Babies are incredibly astute observers because of their spotlight focus on what is in front of them. We miss some of that in casting a wide search beam, even though we take in much, much more.

Here's a good example. I have two young-adult sons. And as a younger parent, I enjoyed taking my boys to the ball game, as my father had taken me to ball games when I was younger. But I was always interested when, especially when the boys were young, about what they reported to their mother about what they really enjoyed about the ball game.

Now, I came home, and I was excited about the score and the fact that it might have been a great pitchers' duel or there were great hits or the beautiful day in this wonderful ball park, and I was expecting the boys would talk about that because that certainly was what captured my attention. Instead, what I usually heard them saying was to their mother how great the taste was of the hot dog that I bought them in the 7th inning stretch and the bald spot on the head of the person sitting in the row in front of them. That is what had captured their attention. Their experience of the game was very much like that spotlight on that immediate experience, where, as my adult experience of it, of course, was that wide beam taking in all aspects of what that's like. That is very much like the thinking of a baby or a young child.

In some respects, the best way that you or I might have of trying to capture what a baby's experiencing of the moment is like is if we were to go to a foreign country, especially an unusual country compared to our own. I had the experience last March of being asked to give a series of talks in Abu Dhabi, a Middle Eastern country, a Muslim country. And because it was so very different from my own experience of living in California, I had, for a couple of days, that experience of being very much in the moment, of being very focused on the people I was with and their practices and their languages and their belief systems and how to interact with them socially and when it was appropriate to shake hands and when it was not appropriate to shake hands and how to think about the ways that people were dressed. And it was just consuming, but it was very much in the moment because I was having the experience of being in a foreign culture, very much like babies are trying to take everything in in the context of their experience in this wide and interesting world.

Of course, what really helps us when we are visitors to a foreign land, as in the movie "Avatar," is if we've got a guide to help us understand what's important, to help us interpret what we're observing, to help us make sense of what we're seeing, and also to tell us what's really not much important. And thus, what we function as for babies and toddlers is to be tour guides to this remarkable world in which they've found themselves, this remarkable foreign culture that they're trying to learn all about, to help them make their way through it, to help them take in all this exciting new stuff, to help them figure out what's important, what's not important, to be tour guides to them for this remarkable world into which they've been born.

Now, there's a fourth reason that the thinking of babies is very different from the thinking of adults kind of related to this, but also different. And it's this: The thinking of babies and toddlers is very focused, rather than wide-ranging. At any moment, we as adults have a lot of things going on in our minds. At this time, for example, I'm concentrating on what I'm trying to say to you.

I've got a part of my mind that's monitoring how well it's coming across. There's another voice in my head that goes, "God, that was really stupid. Why did you say that? That worked out really well. [Laughter] Good job. Let's try better next time." There's also a part of my voice -- a part of me that is taking in the reactions of the people in this room. Fortunately, they laughed just a minute ago. There's also a part of me that is thinking about the flight that I have to go home, the person I'm gonna have lunch with, and also the conversation I had with my son last night.

No wonder we need to be so self-regulating as adults because we've got so much mental activity going on. We need an air-traffic controller. For infants who have less of that conceptual baggage to have to work with, their thinking is not like the wide-open fan, but instead like that fan closed up. Their thinking is very narrow, focused on the immediate experience, and on what is going on within them and around them at the present time. This is why, interestingly enough, transitions can be so hard for young children because, imagine, if you're in the moment, if you are really concentrating on what your current experience is, it's really hard to pull yourself away from that in order to have to move to something else, and the teacher says, "It's time for a snack," or, "It's time to do some other activity." And this is why, as adults, we can be really helpful with that mental focus by, when transitions have to occur, providing some advanced warning and helping children get ready and helping them make their way from one thing that they've been focused on to something else they're going to invest themselves in, as well.

Okay. I've got a fifth and last way in which the thinking of babies is different from that of adults, and this has to do with the role of emotion. Now, so far, we've been talking about the baby as having a brain that's a really sophisticated processor of information and is incredibly competent at taking in information from the present moment. But we've been acting as though that baby doesn't have any feelings at all. And that's not a real baby.

We know that emotions can often motivate a child's learning and discovery, when those emotions are feelings like curiosity and interest and fascination. And indeed, the baby's brain, as an emotional organ as well as an intellectual organ, is often moved along and activated by those kinds of emotional experiences. But we also know that there are other emotional experiences, as well. Those of you who have watched "Inside Out" during the last month or so may appreciate that emotions are important to the experience of a pre-adolescent girl named Riley, but also, emotions are important to babies and, indeed, to all of us.

Where babies differ from adults and even pre-adolescent girls is that they don't have the emotional regulatory capacities to be able to manage the strong feelings of frustration or sadness or distress or anger that may erupt in their everyday experience. And as a result, these emotions can sometimes, and often do, derail a child's learning and discovery from current experience. Caregivers' emotional support can be so important in helping to keep children on track, in helping their brains manage the strong feelings that can erupt at any moment and be able to keep them discovering what is new and exciting about the world around them.

Now, we understand why emotions have this effect on our thinking and reasoning when we turn again to look at the brain. And in this figure, I'm gonna identify a couple of structures and tell you a little bit about why they're so important. You'll notice, for example, this red chili-shaped structure that I just circled. It is called the amygdala. And the amygdala is often seen as one of several emotion centers of the brain, and that is because it is the part of the brain that has to do with fight-or-flight responding. It gives emotional significance to events.

Attached to the amygdala, not just next to it, but attached to the amygdala is another structure that I've identified and circled -- this cucumber-shaped structure that is called the hippocampus. And the hippocampus is a part of the brain that helps to create new memories out of current experience. So it is a memory part of your brain. If tomorrow, you remember something you heard this morning and tell it to a friend, it's because, fortunately, your hippocampus was activated as you were listening to me.

And then finally, this last area of the brain, toward the front of the brain that I've just circled, is a part of the brain called the prefrontal cortex. And it is where the dorsolateral prefrontal cortex and other structures are that have a lot to do with the child's self-regulation.

Now, why have I identified these three areas of the brain? Primarily because they are densely interconnected with each other. As I mentioned earlier, the amygdala and the hippocampus are literally connected, but they are also neuro projections from each of these structures to the others. And this tells us that there's a neurobiological basis for the role that emotion has in our ability to think clearly and focus our attention and remember and how we remember events, and also on our self-regulation. Any of us who can remember having gotten some very distressing news and remembering how much you were in a fog immediately after getting that news can understand this.

But where adults can help to manage their own emotions when they're faced with an upsetting event, babies have limited emotion self-regulation. And as a result, their capacities to self-regulate, their capacities to think, their capacities to learn and remember are more easily deregulated, disregulated, derailed by overwhelming and strong negative emotion. And this is important. This is important not just for what it tells us about how babies think in ways that are different from adults. This is important for another reason also. And that is because it adds to our concern about children who are experiencing chronic stress, including children who are infants and toddlers who experience chronic stress.

Because one of the things the research is showing us is how much regular experiences of stress that can occur when children are living in poverty or economic adversity, that can occur when children are living in families where there's a lot of marital difficulty or domestic violence, and it can occur when children, themselves, are being maltreated or neglected. This chronic stress can have significant effects on children's abilities to manage themselves, to self-regulate, but it also has downstream effects on their thinking, their reasoning, their memory. In short, their learning skills.

And that's why we all ought to be concerned about kids who are experiencing chronic stress, especially early in life, because it really does make a difference. Okay, to summarize, why is babies' thinking different from that of adults? Well, self-regulation is limited, so they have poorer control over attention, behavior, thinking, impulses, and emotions. We're gonna hear more about that from the next speaker. Their minds are excited by novelty. It's why they learn so quickly. And so much of the world is new to them. They're captivated by immediate experience -- the spotlight, rather than the search beam. And so they devote less attention to the wider context.

Thinking is focused, rather than broad-beam, and emotions can both motivate learning, but they can also easily interfere with it. These characteristics of the thinking of babies help to explain why this powerful brain that is developing at such an amazing rate early in life and laying the foundation for learning skills that will color the child's experience in the years to come -- This helps to explain why this powerful brain requires the assistance of sensitive caregivers to provide support and guidance in order to enable the child's brain to benefit from experience and to enable them to focus and learn from them.

And so this leads to the question, of course, "What does all this mean for us?" And I think the first answer to this question is quite simply that in being born into a world of unknowns, when a child has so much that they don't know about the world around them, who you are as a caregiver is as important as what you do in the child's life experience -- that adults -- caring, nurturant, reliable, and sensitive adults become the centerpiece, the main event, of a child's experience because each adult who the child knows becomes a stable source of security and support in a rapidly changing world.

And so in a world of unknowns and a world of so much novelty in which much is changing, children develop emotional attachments to those who provide that island of security and support because you are the centerpiece of a rapidly changing experience. And you are the one who provides the ability to focus, to grow, to self-regulate, to benefit from these experiences in a positive way. Caregivers do this, of course, in all the various ways that we help children and help their brains do the things that they may be less capable of doing.

Caregivers help young children self-regulate, to manage their emotions, to focus their attention and thinking, and to be capable of taking in much of what this amazing world has to offer. Caregivers, as I mentioned earlier, are tour guides helping to draw the child's attention to something that might be an exciting discovery at this moment and avoid being distracted by a petulant frustration or somebody else's interference. Caregivers are also trusted sources of emotional support that provide a haven of safety, especially when things begin to seem overwhelming. And beyond this, what we do in our natural interactions with children also make a difference in who we are to them. Researchers have come to use the term "serve and return" to try to describe this natural back-and-forth interaction that goes on between a sensitive adult and a child who's learning and growing and discovering about the world around them.

Whether it's volleyball, tennis, racquetball, or squash, the idea of serve and return is that at any moment in the volleying back and forth of ideas or feelings or observations or experiences or thoughts, each partner is responding to what the other partner is doing. There's no single set behavior that takes place, but is rather adapting what you're doing to what the other person is doing, and that's how the

game continues. That's how the volley is maintained. So likewise, in our interactions with babies and toddlers, it's our ability to volley back and forth, exchanging feelings and ideas and thoughts and observations and experiences focused on what the child has found interesting and captivating at the moment -- that serve and return -- that a sensitive adult brings to their interactions with a child that not only give the child the opportunity to learn, but also provides the emotional security while doing so.

So in serve and return, new ideas and experiences are discovered because of what is contributed by the partner. In serve and return, there's a confirmation that the child experiences that their own feelings and ideas have worth and are recognized because the other person is responding to them. In serve and return, we help the child focus their attention and their thinking and their feelings in a moment of shared discovery. And in serve and return, we also help to develop the child's own ideas and observations through what we are contributing to help deepen and expand them. Serve and return has proven to be a really useful metaphor for our thinking, and it helps us understand that in what we're doing with a child, we are being focused on the child's experience, but also helping to expand that.

This kind of serve and return can be helpful not only for expanding a child's cognitive skills, but also for strengthening what I call learning skills. That is the skills that help children become more active, self-motivated learners on their own. These are sometimes called non-cognitive skills, but I think that's the wrong term for it. Learning skills also contribute to cognitive development, but they do so by the way that they contribute to the child's curiosity, the child's self-confidence, the child's persistence, the child's motivation to learn. Those are the learning skills that are equally important to develop early in life, and it's the child's curiosity and persistence and self-confidence and motivation to learn that also helps them grow cognitively.

Well, the things we do with children, very young children, also contribute to those learning skills, not just cognitive skills, in how the adult responds to a child's successes and failures, for example, by helping the child take pleasure in their effort, even if it doesn't always result in success, in showing confidence that we believe the child can learn and can master this learning challenge, in helping to convey our own belief that the child can grow and can master and can expand their abilities, a growth mind-set that we bring in our experience with the child we contribute to the child's own growth mind-set, the child's own sense that, "If I keep at this, I can succeed," that, "This looks really interesting.

What can I find out more about this?" That, "I can do this," that, "I can do this." In the early childhood field, some people call these practices an emerging curriculum -- the idea that it's not a curriculum that comes from the teacher. It's a curriculum that emerges spontaneously from what the child is discovering and finding of interest in their daily experience as it is being unfolded by a sensitive caregiver who helps to turn that curiosity into a learning opportunity. Other people call this discovery-based learning or inquiry-based learning.

Some people call it guided participation. But what it all shows is that children, yes, they learn incredibly well on their own, but they also learn excitedly well in the context of social participation with a sensitive adult who, through serve and return, is engaging the mind, focusing the attention, helping to manage emotions, and helping to make this a learning opportunity.

Now, there is also much that we do of very practical ways that contribute to children's cognitive skills. Remember what I said earlier about vocabulary development and about the ways in which there's a vocabulary explosion that takes place in the child's second and third years of life? Well, it turns out that the kind of input, the kind of experiences a child has at home have a lot to do with how that vocabulary explosion unfolds. This was demonstrated a few years ago in a famous study by Hart and Risley in which they studied different families and the children in those families from the time that the children were 9 months old until about three years of age. And they found that that vocabulary explosion unfolded over the months and years of early life in different ways for children in different families.

With, as I mentioned earlier, not much happening before 16 months of age, but at the time that the vocabulary explosion took off, we found the trajectory of children's word learning also was different. And as you can see, children from the most economically advantaged families ended up with vocabulary sizes that were more than twice as large as those from other families they studied.

Now, it turns out the difference was not so much having to do with how rich the family was, but it had to do, that it turned out, they learned, with what was going on within the family -- that in families where children developed a richly large and varied vocabulary, there was a lot of child-directed speech that children were overhearing. They were hearing speech directed toward children in the context of conversation, in the context of storybook reading, in the context of talking about what the child happened to observed during a walk in the park or a trip to the grocery store.

And it was child-directed language that was really important here, not just the child overhearing speech that adults were sharing among themselves. And indeed, this finding has been replicated by other researchers. And the other part of this finding that is important is that it was not just the amount of language that was being heard and the context in which it was being heard, but also the emotional tone in which it was being conveyed.

These researchers created a ratio of positive to negative vocabulary that children were hearing, and they found that in the homes in which children were developing a more rich and varied vocabulary, children were also hearing speech that was of a positive emotional tone, especially as it was directed toward them. And you know what this is like when we use child-directed speech. We're often speaking in a singsong voice and using a melodic tone of voice and basically speaking in a way that would embarrass us if we were with an adult.

By contrast, in homes where children's vocabulary did not develop as much, much more of the words the children were hearing had a negative tone, words that were meant not to unfold the child's experience, but rather to control and direct and manage the child's behavior. A lot of orders and a lot of commands were going on. There are two other things that are remarkable about this that I want to draw your attention to. One is that this kind of speech was important and influential, even before children had uttered their first word. You know, so many parents I talk to say, "Why do you talk to a baby? They can't talk back. They can't understand what you're saying." But in fact, we know that this is the period when the brain is reorganizing itself in order to become an efficient language learner, where the kind of language and how that language is used is already having an influence on the child's developing language skills even before you hear the first word.

And the second thing that's important is that the child's vocabulary size at age 3 in the Hart and Risley study predicted third-grade language skills. So how a child is learning language in the first three years of life does make a difference of long-term significance related to school readiness. It's not just words. It's also, we're discovering, number. Remarkably enough, babies early-develop what we call an approximate number system. They become capable, in other words, of being able to make out the differences between small quantities. They can discern different amounts. They can't count them, but they can discern the differences.

Toddlers, a little bit later, are also beginning to understand one-to-one correspondence. They might not know how to count, but they do know that each number pertains to one and only one element. They're developing number concepts even before they've really developed a working number vocabulary. And in this research, scientists are discovering that how adults talk about number proves to be really important, that the amount of parents' spontaneous number talk in everyday conversations with children -- It ends up having a lot to do with the number concepts that children begin acquiring as they move into the preschool years.

And by number talk, we're meaning simply things like counting things that you happen to run across as you're walking into the market or as you're reading a storybook with a child. We're talking about using number concepts and making references to what time it is. In short, the degree to which adults were infusing number concepts into their everyday language was providing a foundation, even before kids could learn to count for their own growing number ability.

Finally, I want to point out that it's not just these cognitive skills and these learning skills that are facilitated by what we do in our everyday sensitive interactions with very young children, but it's also they're learning about other people. One of the really important discoveries of developmental science in the time that I've been in the field has been the realization that contrary to our earlier beliefs that very young children are egocentric -- In other words, that they're wrapped up in their own subjective experience and their feelings and perspective and have real difficulty understanding how another person could have a different experience of the world than they do.

Researchers have learned that not only are babies and toddlers not egocentric, but in fact, they have, from very early on, an intuitive awareness that what is going on in another person's mind is actually different from what goes on in their own minds. In other words, they have a very non-egocentric awareness that your feelings and thoughts and perspective might be different from my own. It's one of the reasons why you can see 9-month-olds beginning to point to objects that they want to draw an adult's attention to. So something has piqued the child's curiosity, and they want the adult to see that object. And they know that by pointing at it, if the adult looks at that object, it will get in their head, and they will also have the same experience.

And you can observe this because that 9-month-old, that 10-month-old will continue to point and draw attention to it with sounds and gestures until the adult has started looking, reflecting this very rudimentary sense that what the adult is looking at is in their mind. And only when they look at it are they thinking about the same thing you are.

Later on, babies will use this basic idea in a phenomenon we call social referencing, when, if they encounter a strange adult or an unfamiliar object, they will usually turn to their mothers to see how mother is responding to the same person or the object. And based on her emotional expression while she's looking at it, they'll come to their own judgment about whether this thing is safe or dangerous. And indeed, if mother is happening to not look at the object at all, but is distracted by something else, they'll continue to persist in drawing mother's attention to the stranger or the unusual object that is attracting their concern. And only when she looks at it will they read her expression and draw their inference about whether this is a safe or dangerous thing. That's a pretty non-egocentric and a very sophisticated way of understanding that even though I don't know what to think about this friendly but unusual adult, mother might.

And therefore, if I read her expression, which tells me what she's feeling about it when she's looking at it, I might learn something for myself. So, why do I have pictures of broccoli and Goldfish crackers on the screen right now? Well, it's to describe a study to you, an experiment to you that I think is one of the most fascinating examples of the simplicity of developmental science, but also yielding really interesting conclusions. This is a study taking place at the University of California Berkeley by my colleague Alison Gopnik and Betty Repacholi.

And this is an experiment with 18-month-olds who are brought into the lab with their mothers, and when they came into the lab, the toddler sat on their mother's laps in front of a table, and on the opposite side of the table was an experimenter. And in between the two of them were exactly what you see in front of you -- both the Goldfish crackers and a bowl of broccoli. And as the experiment is getting underway, both the child and the experimenter are sampling from each of the bowls of food, and the child, of course, even in Berkeley, is not having any of the broccoli, but they're eating the Goldfish crackers alone, as most toddlers will.

But the experimenter is sampling from both bowls of food and is responding in a very unusual way to each bite. Every time she takes a bite of broccoli, she goes, "Oh, broccoli! I really like broccoli! Broccoli is so good!" And every time she takes a bite of Goldfish crackers, paradoxically, she says, "Ew! Goldfish crackers! I hate Goldfish crackers!" Is this on film? So what she's doing is conveying to the toddler, in a way that a toddler can understand through emotions, her own feelings about the different kinds of food, which happen to be exactly the opposite of the child's preferences.

So, now the crucial moment occurs. The experimenter puts her hand right in between the two bowls of food and says to the child, "I want some more. Give me some more." Now, if the child responded egocentrically, what would she be putting in the experimenter's hand? That's right. She'd be putting in the Goldfish crackers. But in fact, 18-month-olds put broccoli into the experimenter's hand in response to that prompt.

Now, they sometimes did with an expression of, "Really? You want this? Well, if that's what you want, go ahead." But they did so. Their ability to read the experimenter's preferences based on her facial expression when she sampled each of the kinds of food led them to a very non-egocentric awareness of what the experimenter would desire when she was asking for more. That is a profoundly important insight into how people's minds operate.

So, how do children get this insight? Well, one of the ways they do so is as they hear us talk about what goes on in our heads, what goes on in our feelings, what goes on in our thoughts and our expectations and our beliefs or what goes on in the heads of other people as we talk to them about shared experiences, as we discuss -- as we simply mention to them why we're going to the cabinet. "I'm going to the cabinet to get a cup because I want a drink of water," begins helping even babies understand that human behavior is goal-directed and people are intentional and people are seeking to accomplish certain things in the things that they do.

So now they begin trying to figure out, "What is the person trying to do? What is their goal? What are they after here?" We give children insights not only to vocabulary and number skills, but also into human beings in our everyday interactions with them. I want to wrap this up with just some suggestions for what this means practically about how we interact with children in order to foster their learning, in order to help that remarkable brain that is developing, to be able to use all of its potential in learning from everyday experience.

And many of these are ones that I've mentioned, as well -- shared experiences that are rich with language and concepts that bathe a child's mind in words that help to stimulate thinking and understanding. Even before the child can say their first word, these language experiences are having an influence.

Language, also in the context of warm, responsive social interaction -- this serve and return, this back-and-forth of responding to the child's interests and excitement and curiosity and ideas and feelings and concepts all help to affirm that what the child is thinking and feeling is important and expand them. Storybook reading, conversations about the child's experiences, interest in play, can be examples of that kind of responsive back-and-forth. In addition, eliciting the child's own language use when she has become capable of using words, to pull those out of the child because that is reflecting conceptual growth that the child is exercising at that moment.

When I was reading stories to my boys, sometimes it was a matter of simply reading the narrative that was familiar to the child, but pausing before the last word or phrase and letting them fill it in, or looking at a set of pictures and having the child identify things in the picture, rather than my doing it themselves.

And then this idea of mind-mindedness. Mind-mindedness refers to the way in which some adults approach children with the idea of what is going on in that child's mind that helps to explain how they're acting. Mind-minded parents will look at a child's behaviors, even when they're fussy and petulant, and simply ask themselves, "What's she thinking? What's she feeling? What's going on? Is there a goal she's trying to accomplish? Is she frustrated because something is blocking her from accomplishing it?" Going into the child's mind just as the child is trying to understand our minds.

Not all parents, not all adults are mind-minded. I've talked with parents who are asking me usually the question that they most want the answer to, which is, "How do I get my child to stop crying?" And usually, when I ask them, "So, what do you do?" usually they say, "I tell them to stop crying." That's not a very mind-minded approach, as opposed to thinking about, "Why might the child be crying, and how can I respond to that?" Warmly sensitive, responsive care. Assisting the child with self-regulation through developmentally appropriate expectation and guidance with transitions.

If the developing brain is limited in its self-regulatory capacity, we have to help that brain be all that it can be by providing external support for the child's regulation -- their attention, their thinking, their emotions, their behavior. Supporting self-regulation by structuring the child's experience through your own participation and prompts. Your presence is often what helps the child focus their attention, concentrate their thinking, persist, explore further because you're there urging them on, encouraging them, supporting them, showing them that you have confidence that they can figure this one out.

And finally, I mentioned patience with the young child -- recognizing that this child does not think in the same way that adults do. As we begin to appreciate the unique ways that young children -- babies and toddlers -- are thinking and therefore are approaching the world, we have patience with them and are able to provide the assistance they so much need. I hope this has been helpful to you. Thank you again for allowing me to be with you this morning.

[ Applause ]

Spokeswoman: Thank you, Ross. That was wonderful. You gave us so many things to think about. So, we had lots of questions that came through from the virtual audience. And I don't know that we'll get to have you address all of these 'cause there are several. So I'll start out with a question from Christy, who asks, "When parents or caregivers are very rigid and controlling and constantly direct and redirect babies and toddlers thinking they're teaching them to self-regulate, doesn't that actually harm their ability to self-regulate over time? If so, could you explain?"

Thompson: Well, Christy, I think your instincts are right. I think that parents who are providing excessive external control may believe that they are trying to help the child self-regulate by giving direction to the child's behavior. But in fact, a child's ability to self-regulate also involves their ability to sort of think about the consequences of their actions, to be able to consider the alternatives, to be able to predict what will happen if I act in a specific way. And we elicit those kinds of behaviors, those kinds of capacities when we support the child's self-regulation and do so in a developmentally appropriate way.

One way we can do so, for example, is provide the child with choices in which each choice is an acceptable one in the context of what the child needs to be doing. But the child is able to think through the options. "Do you want to clean your room now?" This would be appropriate for an older child, I suppose. "Do you want to clean your room now, or do you want to clean it after dinner?" would be one example. Or, "Would you like a bath now, or would you like a bath later on?" No question about having a bath. It's been a long day playing outside. But being given the choice, the child can think about both what choice they want, but also about the various options -- the various consequences of each of the options. Is that helpful?

Spokeswoman: Yes. Thank you.

Thompson: Christy, is that helpful? I hope so. Tell the parents the child is ready to begin making decisions, and giving them options where they're acceptable can be really helpful.

Spokeswoman: Great. Thank you. "When working with infants and toddlers that we know have had significant birth trauma or trauma in their early months, what types of signs might childcare staff look for to assess how they are adapting?"

Thompson: Do you have a name for that one?

Spokeswoman: No, I don't have a name for that one?

Thompson: Okay. The things I would like to know about this question is what is the nature of the trauma that the child experienced early on, and how old is the child now where you're looking for signs of how well the child is adapting. Our concerns are often with what can be the downstream effects of both single traumatic experiences, but also of chronic traumatic experiences, such as when children are growing up in an abusive home or the family is in serious economic difficulty, where neglect can be a real serious concern.

In circumstances like this, one of the things I researched tells us is that the child's own biological stress capacities themselves become dis-regulated as the result of early and severe and chronic trauma. And we know this biologically in looking at the nature of their cortisol responses, but we also see it behaviorally in kids often who become hyper-reactive to signs of threat or danger, who respond with greater intensity and extremity to minor challenges that other kids would not be fazed by. Or who fall apart when challenged or who have difficulty even beyond what would be age-appropriate in self-regulating. It's in those circumstances that researchers can sometimes see a dis-regulated biological coping system for managing stress. And when children, by contrast, begin to become capable of managing challenge or threat or moderately difficult circumstances with the assistance of a caregiver and can begin managing their own arousal, that's when we know they're beginning to adapt appropriately. Those are the things we look for. But throughout this, children need help in this kind of self-regulation.

Spokeswoman: Thank you. This question is from Ophelia, and she wants to know, "If the child knows many languages, how does this help their mind?"

Thompson: Ophelia, that's a great question. You must be a developmental scientist because there are lots of researchers who are looking at that question right now. Well, first of all, one of the things we know in contrast to what we believed a generation ago is that becoming bilingual, becoming multi-lingual, does not in any significant way impair children's language competence. Children do not fall behind in their language learning as a result of learning more than one language. In fact, to a remarkable degree, and a way that reflects how the brain has re-wired itself to become an optimal language learner, young children don't seem to have any trouble with the code switching that's involved in moving from one language to the other, such as speaking one language with one parent and a different language with another parent, or speaking one language at home or a different language in a different context. That doesn't seem to be a problem.

And although we can see in some circumstances where a child might be substituting, say, a noun in an alternative language when they can't quite come up with it in the language they're speaking in, that kind of switch is actually very adaptive. It shows the child's using any language they have to communicate. And so it's not reflecting a confusion. What the research seem to be indicating, however, is that there may be some unique advantages for kids who are growing up multi-lingual, and in particular, some evidence that children's executive function skills, which you'll be hearing about in the next talk, may be more advanced in children growing up in a multi-lingual environment. And the suggestion here is that the cognitive skills required to be able to, in a sense, juxtapose more than one language may be contributing to this executive-function capacity.

Spokeswoman: Great. Thank you. Question from Heather. "What are some additional strategies teachers and caregivers can use to support their own regulation when faced with behaviors that are triggering them?"

[ Laughter ]

Thompson: Heather, that's the kind of question that I think anybody who works with young children has to ask. And what it presumes, of course, is that you need to be competently self-managing if you're gonna be a good teacher. And I think that is good wisdom. The challenge, of course, is that in many of the settings in which we're working, it's often hard to be able to do some of the things that we might do as adults to be able to manage our own growing frustration or other emotions. We can't walk into a closet and breathe deeply until we're calmed down and then walk out again and be able to respond to the kids again. Some of this, therefore, involves how teachers are supporting each other in the context of a classroom environment, as well as the strategies that you can use as an individual in order to, in the moment, be aware of what you are feeling, be cognizant, be thoughtful about where your emotions are leading you or the ways in which one or more children may be pushing your buttons. And in that, have at hand -- And the strategies are going to vary for different teachers -- alternative strategies that you can use that will help to make things work better for you. It may involve duck-walking.

That is, finding an activity that will deactivate a confrontational situation and take that child off with you or with another teacher in an alternative activity. It may involve starting a song that may seem out of context in that context, but helps you begin engaging them in something else besides what it is that it proving to be so frustrating and difficult. Or it may involve enlisting a colleague and saying, "This is getting out of control. Can you help me? I need a break." But those kinds of strategies developed in the context of working with other staff can be so important in helping you be the kind of teacher you need to be. I hope that's helpful, Heather.

Spokeswoman: That's very helpful. And I was just speaking as you were talking, Ross, we have lots of program staff out there that are working in a home-based setting -- home visitors that engage with parents. Are there specific things that they might do as they're working with the parents to really think about some of these concepts that you shared with us today?

Thompson: Well, I think that -- I was initially thinking that you were asking that question with respect to the parents on self-regulation, but you're thinking more generally in terms of all this. I think that as much as the brain-development research has been such a game changer for our changing, in historic ways, our understanding of the early years. I mean, it really is true that you can go out on the streets of your town and ask a random person what they know about brain development, and they'll be able to tell you that there's important stuff going on in the early years.

They just don't know what to do about it. As much as that brain-development research has been a game changer, there's still a lot of misunderstanding about babies and toddlers. There's misunderstanding about their egocentrism. There's misunderstanding about how much they can regulate their own behavior. There's misunderstanding about how language could possibly be important before they can utter their first word.

There's misunderstanding, most of all, about what it is that adults can do, short of using flash cards or doing "Baby Einstein" DVDs, that will really make a difference to their children's development. And if you go on to say that it's a matter of developing secure relationships, they'll often ask you, "What does that mean?" because oftentimes, parents of very young children don't think about having a relationship with a child so young. So we are in a position of helping to bring this knowledge that is so important to the work that we do to the awareness of parents to help them become mind-minded in a new way. And that's really the goal we have for them.

Spokeswoman: Wonderful. I think we're going to end there, Ross, because we're time-sensitive. So I apologize to everybody who had questions out there that we didn't get a chance to present to Dr. Thompson. Thank you so much. That was wonderful.

Thompson: Pleasure.

[Applause]